

Patent claims

1. A method for the separation of macromolecules from their mixtures of high and low molecular substances characterized in that
 - at least one non-porous polymer film is utilized as a separation medium by exploiting the permeation of the film
 - films are considered non-porous if their pores do not completely impenetrate the film from side to side
 - during separation, the temperature of the at least one non-porous polymer film is equal to or greater than the glass transition temperature of the amorphous regions of said at least one polymer film used for the separation.
2. A method according to claim 1, characterized in that, in the case that the temperature of the at least one non-porous polymer film utilized as a separation medium is lower than the glass transition temperature of the amorphous regions of this at least one non-porous polymer film, this glass transition temperature will be lowered before the start of separation by swelling with a solvent to a level below or equal to the temperature of the at least one non-porous polymer film utilized as a separation medium.
3. A method according to claim 2, characterized in that the solvent contains at least one liquid from the group of protic, aprotic, aqueous, aliphatic, aromatic, heteroaliphatic, heteroaromatic, alicyclic, and/or heteroalicyclic liquids.
4. A method according to one of the claims 1-3 characterized in that the at least one polymer film utilized for the separation consists of one or more of

the following polymers and/or contains one or more of the following polymers selected from the group of polymers such as poly-(p-xylylene), polyvinylidene halides, polyester, polyether, polyolefins, polycarbonates, polyurethanes, natural polymers, polycarboxylic acids, polysulfonic acids, sulphated polysaccharides, polylactides, polyglycosides, polyamides, polyvinylalcohols, poly- α -methylstyrenes, polymethacrylates, polyacrylnitriles, poly-(p-xylyles), polyacrylamides, polyimides, polyphenylenes, polysilanes, polysiloxanes, polybenzimidazoles, polybenzthiazoles, polyoxazolines, polysulfinides, polyesteramides, polyarylenvinylenes, polyetherketones, polyurethanes, polysulfones, ormocerenes, polyacrylates, silicones, fully aromatic copolyesters, poly-N-vinylpyrrolidones, polyhydroxyethylmethacrylates, polymethylmethacrylates, polyethylenterephthalates, polymethacrylnitriles, polyvinylacetates, neoprene, Buna N, polybutadienes, polytetrafluorethylenes, modified or unmodified celluloses, α -olefins, vinylsulfonic acids, maleic acids, alginates or collagens.

5. A method according to one of the claims 1-4 characterized in that the monomers that form the basis of the at least one polymer film can each support one or more functional groups, whereby each case is a singular type or different types of the substituents H, linear or branched alkyl, alkenyl, alkynyl, cycloalkyl, cycloalkenyl, cycloalkynyl, phenyl, phenylalkyl, phenylalkenyl, phenylalkynyl, phenylcycloalkyl, phenylcycloalkenyl, phenylcycloalkynyl, cycloalkyl-alkyl, cycloalkyl-alkenyl, cycloalkyl-alkynyl, heterocyclic compounds, heterocyclo-alkyl, heterocyclo-alkenyl, heterocyclo-alkynyl, linear or branched

alkylsulphonate, alkenylsulphonate, alkynylsulphonate,
 linear or branched alkylbenzenesulphonate,
 alkenylbenzenesulphonate, alkynylbenzenesulphonate,
 aminosulphonyl-alkyl, aminosulphonyl-alkenyl,
 5 aminosulphonyl-alkynyl, aminosulphonyl-cycloalkyl,
 aminosulphonyl-cycloalkenyl, aminosulphonyl-
 cycloalkynyl, linear or branched alkyl-sulphonamide,
 alkenyl-sulphonamide, alkynyl-sulphonamide, cycloalkyl-
 sulphonamide, cycloalkenyl-sulphonamide, cycloalkynyl-
 10 sulphonamide, phenyl-sulphonamide, heterocyclo-
 sulphonic acid, heterocyclo-sulphonamide, heterocyclo-
 alkyl-sulphonic acid, heterocyclo-alkyl-sulphonamide,
 heterocyclo-alkenyl-sulphonic acid, amide- or esterlike
 bound linear and/or branched-chain aliphatic sulphonic,
 15 carbolyxic, and/or phosphonic acid, styrene sulphonic
 acid, anetol sulphonic acid, styrene phosphonic acid,
 heterocyclo-alkenyl-sulphonamide, heterocyclo-alkynyl-
 sulphonic acid, heterocyclo-alkynyl-sulphonamide, aryl-
 sulphonic acid, aryl-sulphonamide, aryl-alkyl-sulphonic
 20 acid, aryl-alkyl-sulphonamide, aryl-alkenyl-sulphonic
 acid, aryl-alkenyl-sulphonamide, aryl-alkynyl-sulphonic
 acid, aryl-alkynyl-sulphonamide, alkyl-, alkenyl,
 alkynyl-, aryl-, heteroalkyl-, heteroaryl-carboxylic
 acids, esters thereof, carboxylic acid amides thereof,
 25 amino acids, orthologous phosphonic acid derivatives of
 all sulphonic acids listed, hydroxy-alkyl-, hydroxy-
 alkenyl-, hydroxy-alkynyl-, hydroxy-cycloalkyl-,
 hydroxy-alkyl-cycloalkyl-, hydroxy-cycloalkyl-alkyl-,
 hydroxy-phenyl-, hydroxy-alkyl-phenyl-, hydroxy-phenyl-
 30 alkyl-groups as well as the orthologous amino- and
 thio- compounds, polyethoxy-alkyl, polyethoxy-alkenyl,
 polyethoxy-alkynyl, polyethoxy-cycloalkyl, polyethoxy-
 cycloalkenyl, polyethoxy-cycloalkynyl, polyethoxy-aryl,
 polyethoxy-alkyl-aryl, polyethoxy-heterocycloalkyl,

- polyethoxy-heterocycloaryl, alkanal, alkenal, alkinal, cycloalkenal, benzene carbaldehyde, heteroaryl-carbaldehyde, benzyl-alkyl-carbaldehyde, heteroaryl-carbaldehyde, aliphatic heteroalkyl-alkenal, hetero-
- 5 alkenyl-alkenal, hetero-alkinyl-alkenal, alkanon, alkenon, alkinon, cycloalkyl-alkanon, dicycloalkanon, arylalkanon, heteroaryl-alkanon, imines, halogens und halogenated derivatives of all groups listed, nitriles, isonitriles, sulphonic acid esters, phosphonic acid
- 10 esters, nitro compounds, hydroxylamines, allyl compounds, adenosin-3',5'-monophosphate, adenosin-3',5'-diphosphate, adenosin-3',5'-triphosphate, guanosin-3',5'-monophosphate, guanosin-3',5'-diphosphate, guanosin-3',5'-triphosphate,
- 15 dextranulphate cellulose, cation exchanging groups, anion exchanging groups, wherein alkyl preferably stands for a group with 1-20 carbon atoms, alkenyl and alkinyl preferably stand for mono- or polyunsaturated groups with 2-20 carbon atoms, cycloalkyl, -alkenyl and
- 20 -alkinyl preferably stand for a group with 3-20 carbon atoms, the heterocyclic groups preferably stand for an R group with 1-20 carbon atoms, wherein up to 5 carbon atoms can be replaced by hetero atoms selected from the group nitrogen, oxygen, sulfur, phosphorus, aryl
- 25 preferably stands for an aromatic R group with 5-20 carbon atoms, heteroaryl stands for a corresponding aromatic R group, wherein up to 5 carbon atoms are replaced by hetero atoms, which can be selected from the group nitrogen, oxygen, sulfur, phosphorus.
- 30 6. A method according to one of the claims 1-5 characterized in that macromolecular components with a molecular weight between 50 g/mol and 500,000 g/mol, preferably between 1,000 g/mol and 50,000 g/mol, pass the permeation layer.

7. A method according to one of the claims 1-6
characterized in that for separation, at least one
polymer film with a thickness equal to or smaller than
100 micrometers, preferably a thickness equal to or
5 smaller than 50 micrometers, with special preference
for a thickness equal to or smaller than 1 micrometer,
with very special preference for a thickness equal to
or smaller than 100 nanometers.
8. A method according to one of the claims 1-7
10 characterized in that at least one semi-crystalline
polymer film is utilized for the separation.
9. A method according to one of the claims 1-8
characterized in that chemically cross-linked polymer
films are utilized for the separation.
- 15 10. A method according to one of the claims 1-9
characterized in that for the separation, at least one
polymer film is utilized which consists of block
polymers, graft copolymers, or blends.
11. A method according to one of the claims 1-10
20 characterized in that multi-layer films are utilized
for the separation, wherein such polymer films are
considered multi layer films which consist of at least
two layers of differing or identical polymers.
12. A method according to claim 11 characterized in that a
25 multi layer film is utilized in which the first polymer
film is directly coated with the other polymer films.
13. A method according to one of the claims 1-12
characterized in that for the separation, at least one
polymer film is utilized which consists of several
30 polymers with different chemical structures.
14. A method according to one of the claims 1-13
characterized in that for the separation, at least one
polymer film is utilized which features a chemical
gradient.

- 15.A method according to one of the claims 1-14
characterized in that for the separation at least one
polymer film consisting of reactive polymers is
utilized.
- 5 16.A method according to one of the claims 1-15
characterized in that for the separation at least one
polymer film is utilized which features a rough and/or
porous surface topology.
- 10 17.A method according to one of the claims 1-16
characterized in that for the separation at least one
polymer film containing solid flux is utilized.
- 15 18.A method according to one of the claims 1-17
characterized in that for the permeation, at least one
polymer film that is coated on or between porous
substrates is utilized.
- 20 19.A method according to one of the claims 1-18
characterized in that for the separation at least one
polymer film is utilized which features other
geometries, preferably a polymer film consisting of
hollow fibers.
- 25 20.A method according to claim 19 characterized in that
the diameters of the hollow fibers' wall thicknesses
are equal to or smaller than 5 micrometers, preferably
equal to or smaller than 500 nanometers, with special
preference for those that are equal to or smaller than
50 nanometers.
- 30 21.A method according to one of the claims 1-20
characterized in that the polymer systems to be
separated are presented dissolved in one single solvent
or mixture of solvents.
- 22.A method according to one of the claims 1-21
characterized in that the solution to be separated,
which contains at least one macromolecule, has a

portion of this one or more macromolecule/s of between 0.1 and 50 percent of its weight.

- 23.A method according to one of the claims 1-22
characterized in that the separation is carried out in
5 combination with light dispersion and/or viscosimetry
and/or UV-Vis spectroscopy and/or gel permeation
chromatography and/or solvent precipitation.
- 24.A method according to one of the claims 1-23
characterized in that the pressure is adjusted in a
10 controlled manner.
- 25.A method according to one of the claims 1-24
characterized in that tandem configurations are
utilized, whereby the term "tandem configurations"
refers to such systems in which several permeation
15 configurations, i.e. configurations with at least one
non-porous polymer film each, are aligned parallel
and/or one after the other, wherein between these
permeation configurations there is a liquid medium.
- 26.Utilization of separation media containing at least one
20 non-porous polymer film for the separation of one or
more macromolecules from their mixtures with high or
low molecular substances in respect to their molecular
weights, their chemical structure, and/or their degree
of branching.
- 25 27.Utilization of separation media containing at least one
non-porous polymer film according to claim 26,
characterized in that macromolecules with a molecular
weight between 50 g/mol and 500,000 g/mol are
separated.
- 30 28.Utilization of separation media containing at least one
non-porous polymer film according to claim 26,
characterized in that macromolecules with a molecular
weight of more than 500,000 g/mol are purified.

29. Utilization of separation media containing at least one non-porous polymer film according to claims 26 to 28, characterized in that one or more macromolecules from byproducts in the synthesis of macromolecules and/or from catalysts and/or from colloidal additives are separated.
- 5